Bridging the Communication Gap: Conceptualizing Issues of Learnability in Using Intelligent Personal Assistants

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Abstract
Using intelligent personal assistants becomes part of people's daily life. Such software assistants intend to help users access information in a timely manner via their dialogue interfaces. However, current designs may not fulfill users' expectations because of people's limited understanding of the capabilities and constraints of intelligent personal assistants. In this position paper, we're aware of the issues of software learnability of potential threat of learned helplessness when users keep receiving unexpected consequences during interactions. We consider tutorial support for learning how to talk to IPAs is required in order to bridge the gap between users and the software assistants. In order to enhance learnability of the assistants, we plan to delineate a design space with strategies of learning scaffolds.

Author Keywords
Intelligent Personal Assistant; Dialogue Interface; Learnability; Learned Helplessness; Scaffolding.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

In recent years, we've seen the emergence and growing of commercialized intelligent personal assistants (IPAs) as a solution for users to interact with mobile devices like smart phones or Internet-of-Things devices in contexts like smart home. IPA is characterized by using natural language interaction as a model of human-machine interaction, which entails speech recognition functionality, and the ability to provide natural language feedback to users instantly. Some popular IPAs today include Apple Siri, Google Assistant, Microsoft Cortana, etc.

As an intuitive way to use IPAs, users can simply ask questions or give commands to IPAs, and then ideally they should receive relevant and useful feedback from the system instantly. Common questions users may ask IPAs may include "*How's the weather today?*" or "*When is the next meeting on my schedule?*" While most IPAs should have been optimized for handling these everyday questions, there remain several sources of uncertainty to the users when interacting with the systems, such as users' accents, paraphrasing, partial or fragmented utterances, and lack of knowledge about what the software assistant can do and/or cannot do, etc. As a result, users may over-expect or under-expect what the system can offer, and may encounter failures in achieving their goals. There can exist a gulf between users' expectations and actual experience when using IPAs [4][7].

Unfortunately, IPAs typically give only general feedback like "*I'm sorry, I can't understand what did you mean.*" without providing further information when errors occur and when the system detect them Since the feedback lack useful hints, users can have difficulties figuring out what happened and how to solve it. There're also situations where the system misrecognize or "misunderstands" users' speech input, generating feedback or providing information that doesn't address users' goals. In our observation, it is problematic for users to build appropriate, usable mental model of IPAs by simply interacting with them as if they're interacting with real people. Strategic support is likely needed to help people learn how to use IPAs in order to bring the potential benefits of IPAs into reality.

In this position paper, we aim to raise the awareness of communication problems between human users and IPAs. Since feedback provided by IPAs often lack clues, there is a need to learn how to communicate with IPAs. We discuss the concerns of learnability of IPAs, and caution that lack of design or support for this concern may lead users to gain learned helplessness in the process. One of the design options is to provide in-situation, knowledge-filling feedback to help user learn IPAs [10].The feedback can be presented in text or in visualization, which aims to provide users with minimal necessary knowledge on how to communicate their needs with the IPAs when relevant errors were detected. The feedback serves as flexible scaffolds rather than coercive instructions, which aims to preserve perceived controllability of users.

The Communication Problems between Users and IPAs

The Venn diagram in Figure 1 shows the general concept of the relationship between user expectation and IPAs ability in the process of interaction. The left circle represents the capabilities of IPAs while the right circle represents user's' expectation. We may model the interaction between users and IPAs as a process of

interpersonal communication. Building shared knowledge or common ground is an essential part of smooth exchange in interpersonal communication [1]. In order to meet users' expectation, we note that the communication between humans and IPAs are no exception, and common ground is still needed to ensure satisfactory experience out of the interaction [8]. If users can't perceive what IPAs can do, they are prone to have over-expectation or under-expectation. On the other hand, if IPAs speculate users' intentions inaccurately, it would introduce frustration to users because of failure. These observations point out that knowing IPAs' ability is a prerequisite for users to communicate with IPAs smoothly.

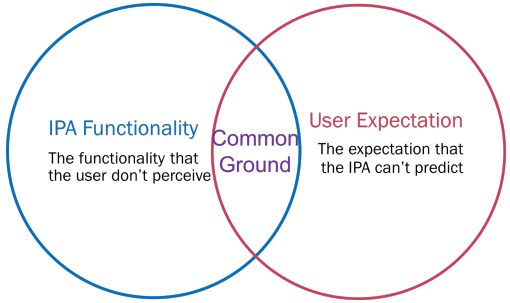

Figure 1: The relationship between IPA functionality and User expectation. The overlapping section represents common ground where IPA meets the user's expectation.

Moreover, the circles are rather dynamic than static for two reasons. On one hand, the functionality of IPAs (e.g., natural language understanding) can be enhanced gradually so the left circle of IPA functionality may extend, covering a larger area of the right circle of user expectation over time. On the other hand, if users are provided with support to recognize IPA functionality, such as visualization or useful feedback, they may have a more realistic expectation of what IPA can do (and cannot do) and self-adapt when using the software. In this proposal, we focus on supporting users to build more realistic mental representations of IPAs. To enhance the learnability of the software, we see room of improvement with IPAs' feedback. We consider that they may need to be more detailed, contextualized, structural and visual.

Learnability Issues of Using IPAs

Before exploring the possible design alternatives to support learning IPAs, we need to clarify what are the main difficulties that users have. Learnability is one key aspect to evaluate usability. A general definition of learnability from Jakob Nielsen is that "*how easy it is for users to accomplish basic tasks the first time they encounter the design.*" [6]. According to the change of learning time, Grossman et al. suggested the learnability scope contains initial learnability and extended learnability [3].

Initial learnability has a strong relation to users' domain knowledge and experience with provided interface. In the scenario of interacting with IPAs, people without technical background may tend to over-expect about IPAs due to lack of prior experience [4]. As for extended learnability, users need to acquire skills and strategies for using IPAs based on the system feedback or information from other sources after starting using the software assistants [4].

Threats of Learned Helplessness

If users continuously receive non-helpful feedback from the software without clear explanations, it is possible that users may try to repeat their inputs (queries). If the output still doesn't address their needs, they may

choose to give it up and conclude that IPAs are difficult to use or they can hardly learn how to control it. This can be a sign of learned helplessness.

According to the theory of Learned Helplessness [5], if people experience unintended situations, they would attempt to take actions to solve the problems. However, when they fail to change the situations after several trials, the feeling of helplessness can increase and dominate their follow-up experience and behaviors. For instance, they may blame themselves for the failures and feel that it is uncontrollable to the outcomes in the present or future [5]. As a consequence, they may consider whatever actions they take, they are doomed to fail.

We hypothesize that users without sufficient background knowledge of how IPAs work may be more prone to learned helplessness due to over-expectation toward the software. They may tend to anthropomorphize IPAs, interacting with it following the conversational norms of interpersonal conversation. Depending on non-transparency of IPAs, there can be repeated errors in interactions, resulting in technology non-use and non-adoption. Future user research will verify sources of problems and mechanisms behind the issues.

Learning Support Design: Support Using IPAs with Scaffolding Feedback

By gaining richer understanding about the learnability issues for using IPAs, our next goal is to identify a design space for supporting users of various expertise and goals to learn IPAs.

As we have illustrated, one of the reasons why people can't build up proper mental model is that there may exist a gulf between user expectation and experience. This observation suggests that external support is required for the purpose of filing the knowledge gap of the users.

Inspired by the literature of learning sciences, we propose to support learning with scaffolding strategies. The core concept of scaffolding is to provide prompts or system feedback adaptively according to the needs of learners [9]. Instead of instructing learners how to do the tasks directly, the goal is to help learners construct their knowledge about the tasks actively, and thus when they have sufficient knowledge of this domain (interacting with IPAs), the external support or scaffold can then be removed [2]. Scaffold can be designed to enhance initial learnability and extended learnability of IPAs by capturing and modeling users' common errors and problems of interaction at different stages.

Additionally, scaffolding strategies play an important role in increasing users' perceived controllability, which is a key factor to avoid learned helplessness. Giving users the whole picture of the capabilities and constraints of IPAs can help people to constitute a reasonable expectation of them. Also, disclosing the specialties and limitations of IPAs and collecting the genres of users' queries facilitate establishing common grounds between users and IPAs.

For instance, IPAs can provide hints of some simple tasks they can do for users in the initial interaction. Afterward, hints for advanced tasks (e.g., using IPAs to connect third-party services) are given to users according to their queries in the process of interaction.

The structure of scaffolding help people understand IPAs gradually within the reach of the users.

Summary

In this position paper, we discuss about communication issues between human and IPAs due to the gap between humans' expectation and real outcome caused by IPAs. Since sometimes feedback provided by IPAs are not appropriate enough in initial interactions, there is a need for users to understand IPAs ability through system feedback. With scaffolding strategies, we expect to help users build useful mental representations of the system steadily for interacting with IPAs. We also expect that users' perceived controllability can be enhanced in the process.

Acknowledgements

The project is supported in part by Ministry of Science and Technology, Taiwan, R.O.C. (103-2218-E-007-017-MY3 and 105-2628-E-007-004-MY2). We also thank the reviewers for the supportive and constructive comments.

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